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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Jae-Young Anh, *et al.*
Serial No.: 10/621,585
Filed: July 17, 2003
For: SYSTEMS INCLUDING HEATED SHOWER HEADS FOR THIN FILM DEPOSITION AND RELATED METHODS

Commissioner for Patents
Washington, D.C. 20231

STATEMENT OF ACCURACY OF A TRANSLATION
37 CFR 1.52(d), 37 CFR 1.55(a) AND 37 CFR 1.69

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Date: Sep. 13. 2005

Full name of the translator: Song, yun-ho
(Print)

Signature of the translator: [signature]

Post Office Address: # 944-411, Lotte Apt, 9-danji,
Yeongtong-dong, Yeongtong-gu, Suwon-si,
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SEMICONDUCTOR MANUFACTURING APPARATUS FOR DEPOSITING MATERIALS ON SEMICONDUCTOR SUBSTRATES

Field of the Invention

The present invention relates to an apparatus for manufacturing semiconductor devices and more particularly to an apparatus for depositing materials on semiconductor wafers.

Background of the Invention

In general, in the process of manufacturing semiconductor devices, a layer to be used as a dielectric or conductive material of the device is formed on the surface of a wafer by diffusing a gaseous chemical (vapor) onto the wafer, thereby facilitating a chemical reaction in which the layer is formed.

The chemical vapor deposition processes available for forming such a dielectric or conductive layer can be classified as chemical vapor deposition or atomic layer deposition. Also chemical vapor deposition processes can be classified as atmosphere pressure chemical vapor deposition, low pressure chemical vapor deposition or plasma enhanced deposition.

Generally, since low pressure chemical vapor deposition proceeds in a process chamber with a high temperature, a layer formed onto the wafer has high thermal stress and cracks thereon easily occurs.

Also, though plasma enhanced deposition proceeds in a process chamber with a low temperature, they need a plasma generation part in a place which is far from the process chamber, thereby a layout of the

apparatus is complicated. In additions, since radicals generated in a plasma generation part are carried through a long pipe and supplied to the process chamber, they may be recombined during carriage.

Above problems occurs in atomic layer deposition apparatus as well as chemical vapor deposition apparatus.

Summary of the Invention

The present invention provides an improved deposition apparatus, which exhibits better deposition characteristics and structure than previous systems.

According to an aspect of the present invention, a deposition apparatus is provided, which includes a process chamber, a boat on which wafers are placed, and a showerhead that sprays gases in parallel with the surface of the wafers placed on the boat.

According to an example of the present invention, the showerhead includes a housing and a heating part for resolving the gases. An inlet port connected with a pipe is installed on a side of the housing and a spray plate spraying the resolved gases to the process chamber is installed on the opposite side of the housing. The heating part includes at least a hot wire and terminals. The terminals are inserted in both sides of the housing and the hot wire is connected with the terminals. The hot wire is made of catalytic material such as tungsten to accelerate the resolution of the gases and is formed in coil type. An insulator may be inserted between the housing and the terminals and a cooling part is displaced in the outer wall of the housing.

According to another example of the showerhead, the showerhead has

a plurality of plenums and the heating part is installed on the respective plenum.

According to another example of the showerhead, the showerhead has at least a first plenum where first gases flow and at least a second plenum where second gases flows. The heating part or the hot wire is installed in the first plenum. The first plenum has an extended portion projected from the second plenum and the heating part or the hot wire is located in the extended portion to prevent the second plenum from being heated due to heat that is generated from the hot wire.

Brief Description of the Drawings

Additional objects and advantages of the present invention will be more readily apparent from the following detailed description of preferred embodiments thereof when taken together with the accompanying drawings in which:

Fig. 1 is a side view showing a deposition apparatus according to a preferred embodiment of the present invention;

Fig. 2 is a top view of the deposition apparatus of Fig. 1;

Fig. 3 is a sectional view of the deposition apparatus of Fig. 1;

Fig. 4 is a perspective view showing a showerhead according to a preferred embodiment of the present invention;

Fig. 5 is a sectional view taken along line I - I of Fig. 4;

Fig. 6 is a perspective view showing a transformed embodiment of the showerhead of Fig. 4;

Fig. 7 is a sectional view taken along line II - II of Fig. 6;

Fig. 8 is a perspective view showing another embodiment of the showerhead;

Fig. 9 and Fig. 10 are sectional views taken along line Ⅲ-Ⅲ and line Ⅳ-Ⅳ of Fig. 8;

Fig. 11 is a perspective view showing a transformed embodiment of the showerhead of Fig. 8; and

Fig. 12 is a sectional view taken along line Ⅴ-Ⅴ of Fig. 11.

Description of the Preferred Embodiment

The present invention will now be described more fully hereinafter with reference to the attached figures, in which preferred embodiments of the invention are shown.

Referring to Figs. 1, 2, and 3, which are respectively a side view, a top view, and a sectional view showing a deposition apparatus of the present invention, the apparatus includes a process chamber 100, a boat 170, a showerhead 200, and an exhaust portion 300.

The process chamber 100 has four wide main-sidewalls 142 and four narrow sub-sidewalls 144. Radiant heat sources 130 are located on the exterior of the process chamber 100. The process chamber 100 is kept in a moderate temperature by the heat transferred from the radiant heat sources 130, thereby gases that are supplied to the process chamber 100 are adsorbed on wafers. The quartz windows 110 are installed on the inside of the main-sidewalls 142 and radiant heat energy is transmitted from the exterior of the process chamber 100 to the interior of the process chamber 100 through the quartz windows110. Diffuser shield plates 150 are located between the

quartz windows 110 and the interior of the process chamber 100. The Diffuser shield plates 150 diffuse the heat energy emitted from the radiant heat sources 130.

The boat 170 is located at the interior of the process chamber 100. The boat 170 has a plurality of susceptors 172, and wafers are placed on the susceptor 172. The boat 170 may rotate during a process, thereby layers uniformly being deposited on the wafers. The wafers are placed on the boat 170 in a loader (not shown) which is located below the process chamber 100.

The showerhead 200 is installed on one sub-sidewall 144 and has enough length to spray uniformly gases to all wafers which are placed on the boat 170. The exhaust part 300 is installed on an opposite sub-sidewall 144 of the showerhead 200 and may be formed with same length with the showerhead 200. The gases are sprayed in the process chamber 100 in parallel with surface of the wafer through the showerhead 100. So deposition layer can be formed uniformly on all wafers.

Fig. 4 is a perspective view showing the showerhead 200 according to one example of the present invention and Fig. 5 is a sectional view taken along line Ⅰ - Ⅰ of Fig. 4.

Referring to Figs.4 and 5, the showerhead 100 includes a housing 210, a heating part, and a cooling part (not shown). The housing 210 has a four side walls, the spray plate 220 and an inlet plate. The spray plate 220 is installed on a rear side of the housing 210 adjacent to the process chamber 100 and the inlet plate having an inlet port 230 is installed on a front side of the housing 210, that is, on an opposite side of the spray plate 220. The inlet plate may be joined to the housing 210 by screws or welding. Optionally the

inlet plate and the housing 210 may be integrally formed.

The spray plate 220 may be joined/separated to/from the housing 210 and an o-ring may be inserted between the spray plate 220 and the housing 210for sealing. A plurality of spray holes 222 are formed on the spray plate 220 and gases or radicals in the showerhead 200 are supplied to the process chamber 100 through the spray holes 222. Optionally slits may be formed on the spray plate 220 instead of the spray holes 222.

The showerhead 200 has the heating part to resolve the reactant gases that come in the housing 100 through the inlet port 230. The heating part includes a hot wire 260 and terminals 250. The projection 240 is formed on the two side walls that face each other and the terminal 250 is inserted in the projection 240. The hot wire 260 is located in the housing 100 and both ends of the hot wire 260 are respectively connected with the terminals 250. Also, a plurality of the hot wires 260 may be installed on the housing 100.

Referring to Fig. 5, the terminal 250 has a connecting part 252 at one end thereof and the both ends of the wire 260 are connected with the terminals 250. The connecting part 252 has two elastic members with triangle shape. The space with a smaller width than the diameter of the wire 260 is formed between the two elastic members. The hot wire 260 is pushed toward the space between two elastic members to connect the hot wire 260 with terminals 250. An insulator member 254 may be inserted between the terminal 250 and the housing 210.

The hot wire 260 is formed as a coil type to supply a wide heat transfer area, thereby increasing the amount of heat to be transferred to reactant gases. The hot wire 260 is made of tungsten to catalyze the

resolution of the reactant gases. The showerhead 200 includes a cooling part such as a duct (not shown) through that cooling water flow surrounding the housing 210. The cooling part prevents the housing 210 of the showerhead 200 from being heated due to the heat emitted from the hot wire 260.

Fig. 6 is a perspective view showing the transformed example of the showerhead 200 and Fig. 7 is a sectional view taken along line Ⅱ - Ⅱ of Fig. 6.

Referring to Figs. 6 and 7, the housing 210 includes three plenums 212 separated by partitions 216. Each of the plenum 212 has the inlet port 230 where the reactant gases come and the spray plate 220 having holes 222. The terminals 250 are inserted at the both side of all plenums 212 and the tungsten wire 260 is connected with the terminals 250. A different kind of gases respectively flows in a different plenum 212 without mixture. They are supplied to the process chamber 100 through the spray plate 220 after resolved in respective plenum 212.

According to the present invention, since the reactant gases are resolved in the showerhead 200, the process proceeds the chamber 100 with lower temperature for general vertical furnace. So it is prevented that the layer formed on the wafer has high thermal stress, thereby the layer is cracked.

Also, since the reactant gases resolved in the showerhead 200 are supplied to the process chamber 100 without delay, thereby a recombination of radicals being prevented.

Fig. 8 is a perspective view showing the showerhead 200 according the second example. Figs. 9 and 10 are sectional views taken along line Ⅲ-

Ⅲ and line Ⅳ-Ⅳ of Fig. 8.

Referring to Fig. 8, the showerhead 200 has a housing 210, a heating part and a cooling part as the first example. But the housing 210 in the second example includes a plurality of plenums 212 and 214 separated by partitions 216, so that the reactant gases are supplied to the process chamber 100 without mixture.

Referring to Fig. 9 and 10, the length of the first plenum 212 is as same as that of the second plenum 214. The inlet plate having the inlet port 230 is installed on each of the plenums 212 and 214. The spraying plate 220 is located in the opposite side of the inlet plate. First reactant gases are supplied to the first plenum 212 and Second reactant gases are supplied to the second plenum 214. The first gases are gases that are supplied to the process chamber 100 after resolution and the second gases are gases that are supplied to the process chamber 100 without resolution.

The terminals 250 are inserted in the both sides of the first plenum 212 and the wire 260 is connected with the terminals 212. For example, in case forming aluminum oxidation layer on the wafer using the atomic layer deposition apparatus, tri-metal aluminum ($Al(CH_3)_3$, TMA) composed of aluminum and metal ligand is supplied to the process chamber 100 through the second plenum 214. Then water vapor is supplied to the process chamber 100 through the first plenum 212. The water vapor is resolved in oxygen ligand and hydrogen ligand in the first plenum 212. Before the water vapors are supplied to the chamber 100, inert gases such as nitrogen gases may be supplied to the process chamber 100 through the second plenum 214 or a different spray pipe. The number of the first plenum 212 and the second

plenum 214 may be changed according to the number of the reactant gases.

Fig. 11 is a prospective view showing a transformed example of the showerhead 200 and Fig.12 is a sectional view taken along line V - V of Fig. 11.

In case of the second example, the heat emitted by the tungsten wire 260 located in the first plenum 212 is transferred to the side wall of the second plenum 214. Thereby the second reactant gases in the second plenum 214 may be resolved by the heat. According to the second example, the housing 210 has the first plenum 212 supplying the first reactant gases to the process chamber 100 after resolving them and the second plenum 214 supplying the second reactant gases to the process chamber 100 without resolving them. The first plenum 212 is formed longer than the second plenum 214. In other words, the first plenum 212 has an extended part projected from the second plenum 214. The tungsten wire 260 is installed on the extended part in the first plenum 212 to prevent the second plenum 214 from being heated due to heat that is generated from the tungsten wire 260.

The duct 270 may be installed surrounding the extended part of the first plenum 212 and cooling water flows through the duct 270. The duct 270 may be installed on entire outer wall of the first plenum 212 or the housing 210.

If it is necessary to resolve two or more kinds of reactant gases, the reactant gases are supplied to the process chamber 100 through the same first plenum 212. Optionally the housing 210 may comprise a plurality of the first plenums 212 and the reactant gases are supplied to the process chamber 100 through respective the first plenum 212.

The process about single wafer or a plurality of wafers is performed in the process chamber and atomic layer deposition process as well as chemical vapor deposition process may be performed in the apparatus of the present invention

Various embodiments and changes may be made thereonto without departing from the broad spirit and scope of the invention. The above-described embodiments are intended to illustrate the present invention, not to limit the scope of the present invention. The scope of the present invention is shown by the attached claims rather than the embodiment. Various modifications made within the meaning of an equivalent of the claims of the invention and within the claims are to be regarded to be in the scope of the present invention.

WHAT IS CLAIMED IS:

1. An apparatus for depositing a thin layer on the surface of the wafer, comprising:

a process chamber;

a susceptor being located in the process chamber and supporting a wafer placed thereon; and

a showerhead for spraying gases toward the wafer placed on the susceptor; the showerhead having a heating part therein for resolving the gases.

2. The apparatus of claim 1, wherein the process chamber further comprises a boat having a plurality of the susceptors;

the showerhead spraying the gases in parallel with surfaces of the wafers.

3. The apparatus of claim 1, wherein the showerhead comprises:

a housing;

an inlet port connected with a pipe through which the gases flows; and

a spray plate for spraying the gases to the process chamber;

wherein the heating part resolving the gases includes at least a hot wire.

4. The apparatus of claim 3, wherein the hot wire is made of

catalytic material to accelerate the resolution of the gases.

5. The apparatus of claim 4, wherein the hot wire is made of tungsten.

6. The apparatus of claim 3, wherein the hot wire is formed as coil type.

7. The apparatus of claim 3, wherein the housing further comprises a terminal that is inserted in the side thereof,

the hot wire is connected with the terminal and is heated thereby.

8. The apparatus of claim 7, wherein the terminal has an elastic connecting portion where the hot wire is connected.

9. The apparatus of claim 8, wherein the showerhead further comprises an insulator which insulates the housing from the terminal.

10. The apparatus of claim 3, wherein the showerhead further comprises a cooling portion to cool an outer wall of the showerhead.

11. The apparatus of claim 10, wherein the cooling portion includes a duct that is located surrounding the showerhead, cooling water flowing through the duct.

12. An apparatus for depositing a thin layer on the surface of wafers, comprising:

a process chamber;

a boat being located in the process chamber and supporting wafers placed thereon; and

a showerhead for spraying gases parallel with the surface of the wafers, the showerhead having a plurality of plenums where a plurality kinds of gases respectively come, the respective plenums having a heating part for resolving the gases.

13. An apparatus manufacturing semiconductor devices for depositing a thin layer on the surface of wafers, comprising:

a process chamber;

a boat being located in the process chamber and supporting wafers placed thereon;; and

a showerhead having at least a first plenum where first gases flow and a second plenum where second gases flow, the first plenum having a heating part for resolving the first gases, the showerhead spraying the resolved gases in the first plenum and the second gases in the second plenum in parallel with a surface of the wafers placed on the susceptor.

14. The apparatus of claim 13, wherein the first plenum has an extended portion that is projected from the second plenum,

the heating part being located in the extended portion to prevent the second plenum from being heated due to heat that is generated from the heat

part.

15. The apparatus of claim 13, wherein the showerhead further comprises the duct that is located surrounding the extended portion, cooling water flowing through the duct.

16. The apparatus of claim 13, wherein the apparatus is an atomic layer deposition apparatus.

17. The apparatus of claim 13, wherein the apparatus is a chemical vapor deposition apparatus.

Abstract of the Disclosure

Provided is an apparatus for depositing materials on semiconductor substrates. The apparatus comprises a process chamber, a boat on which wafers are placed, and a showerhead that sprays gases in parallel with the surface of the wafers placed on the boat. The showerhead includes a heating part for resolving the gases therein.

Fig. 1

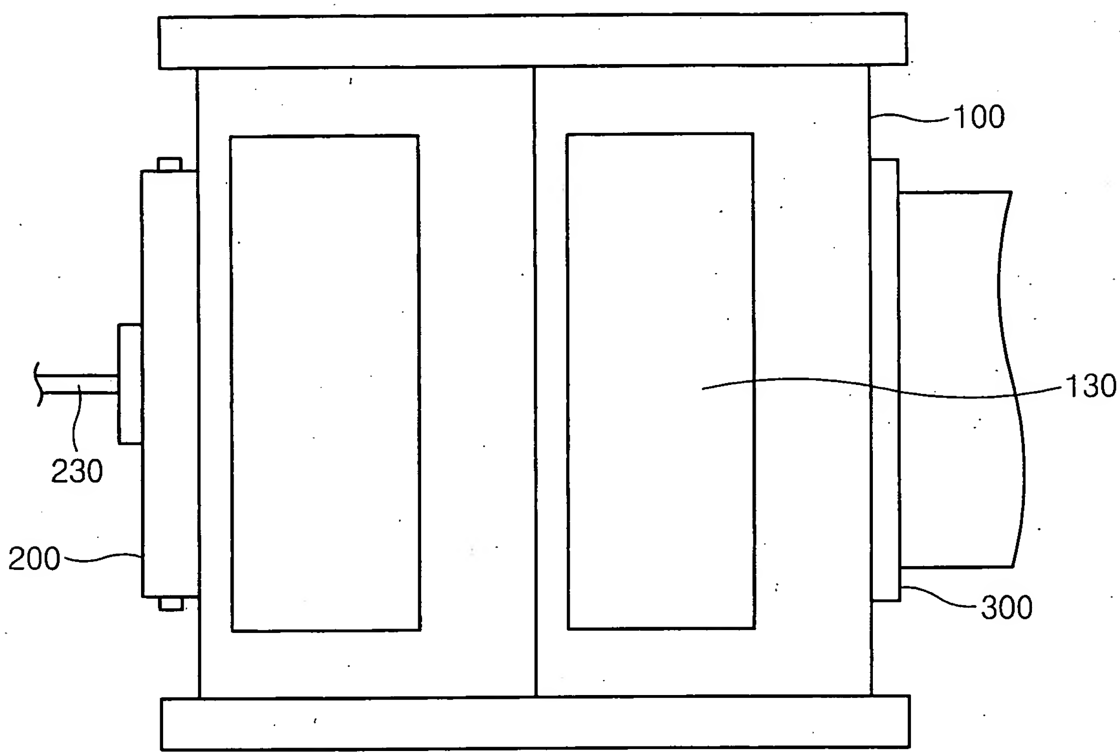

Fig. 2

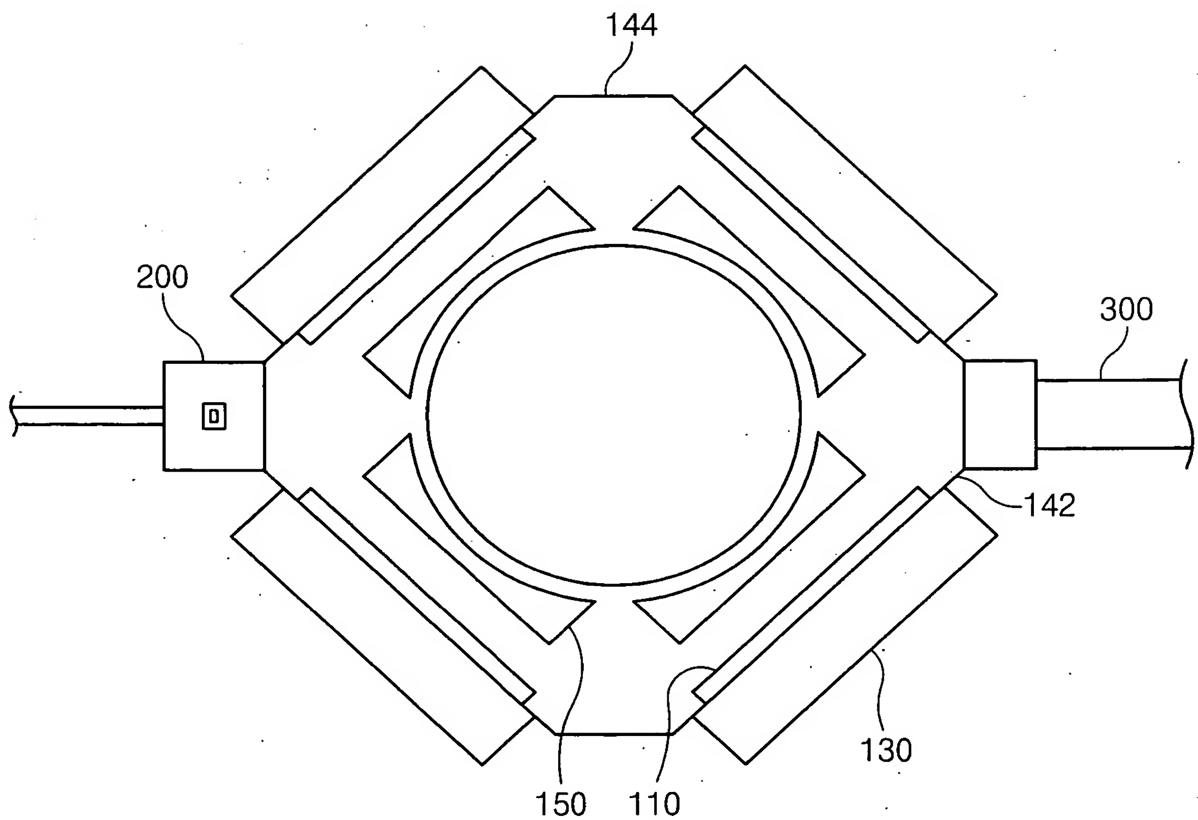

Fig. 3

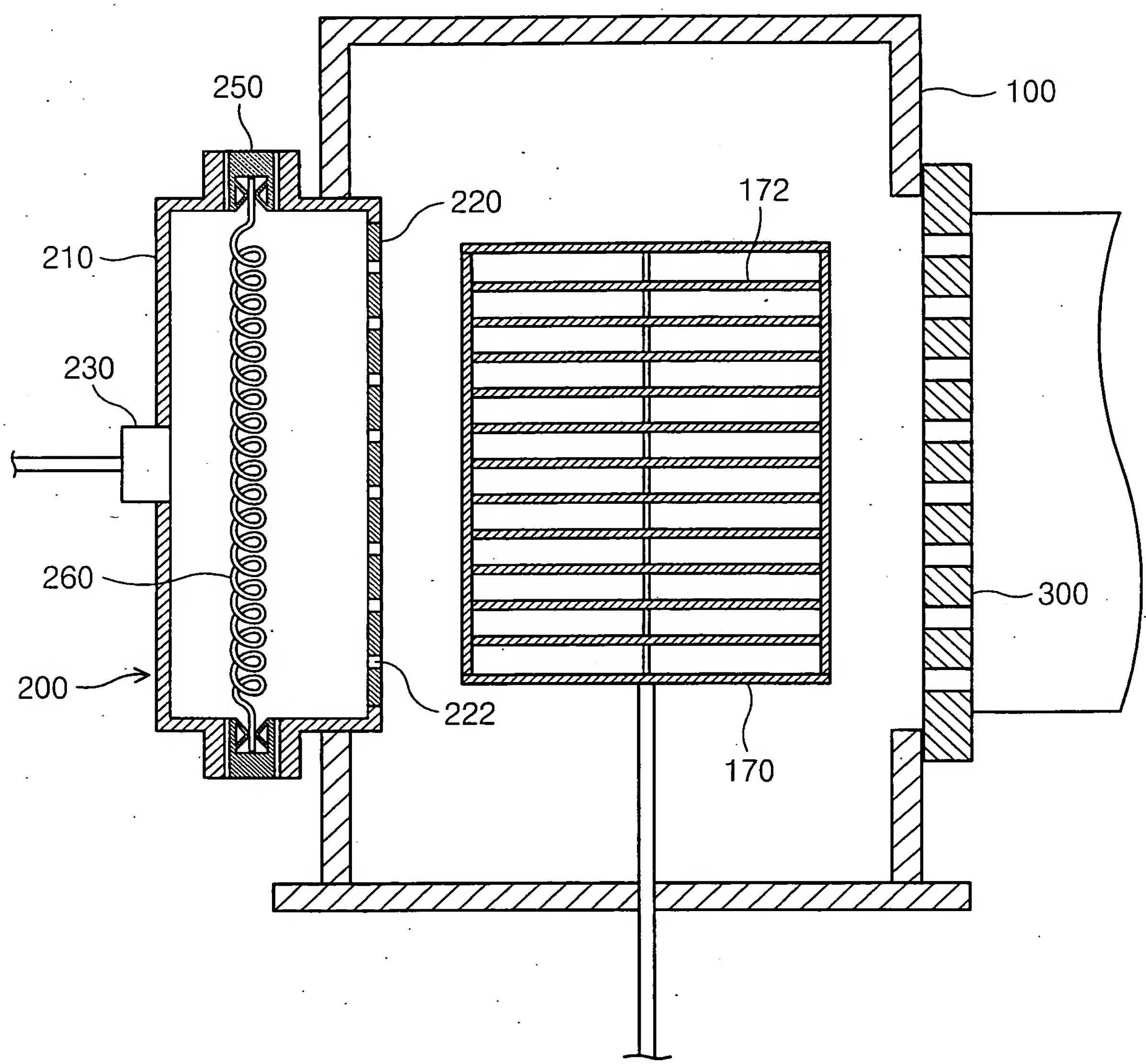

Fig. 4

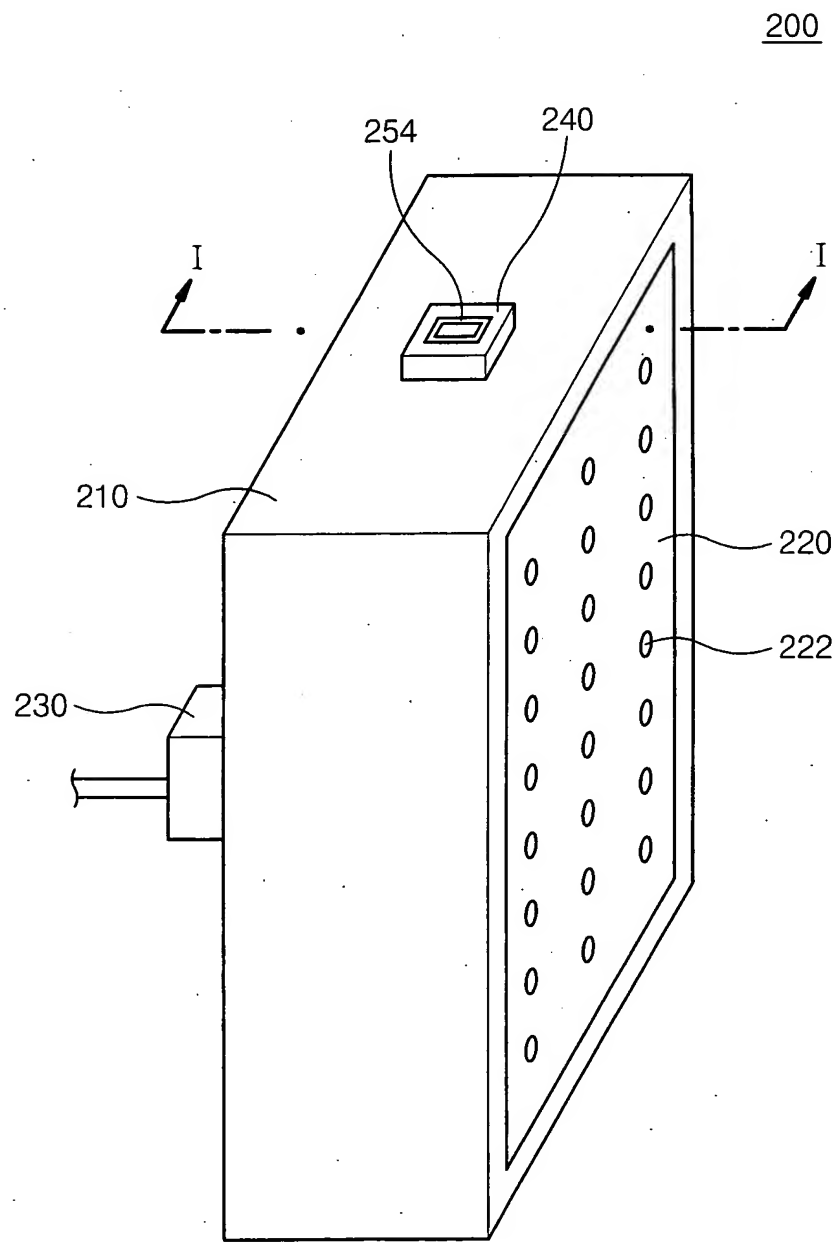

Fig. 5

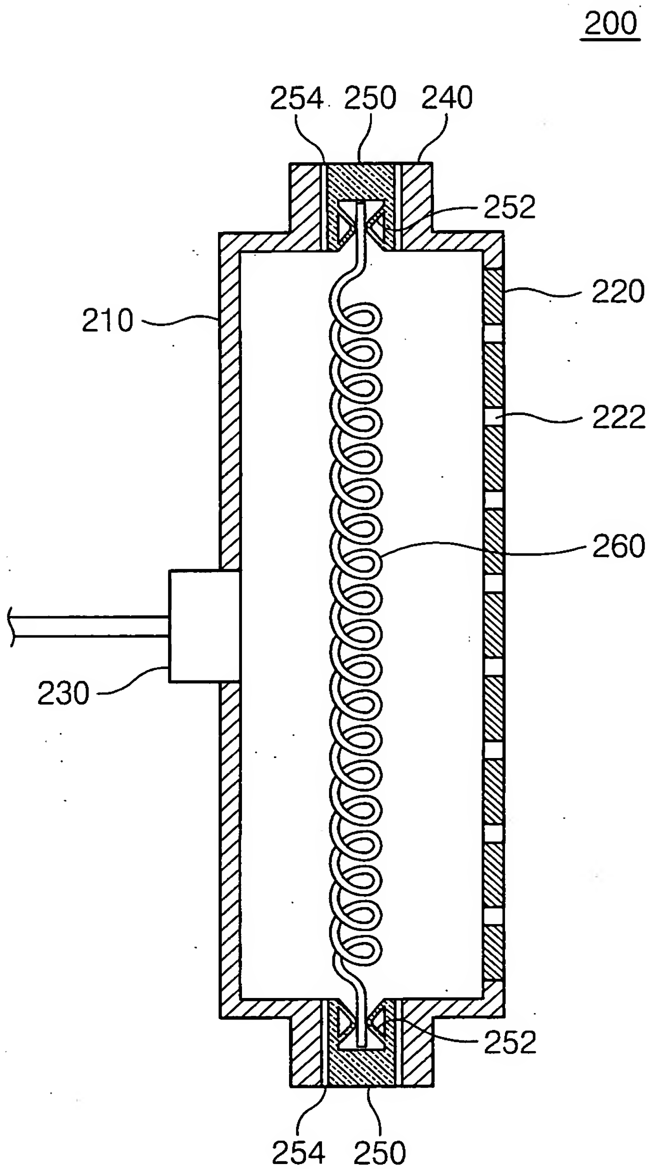

Fig. 6

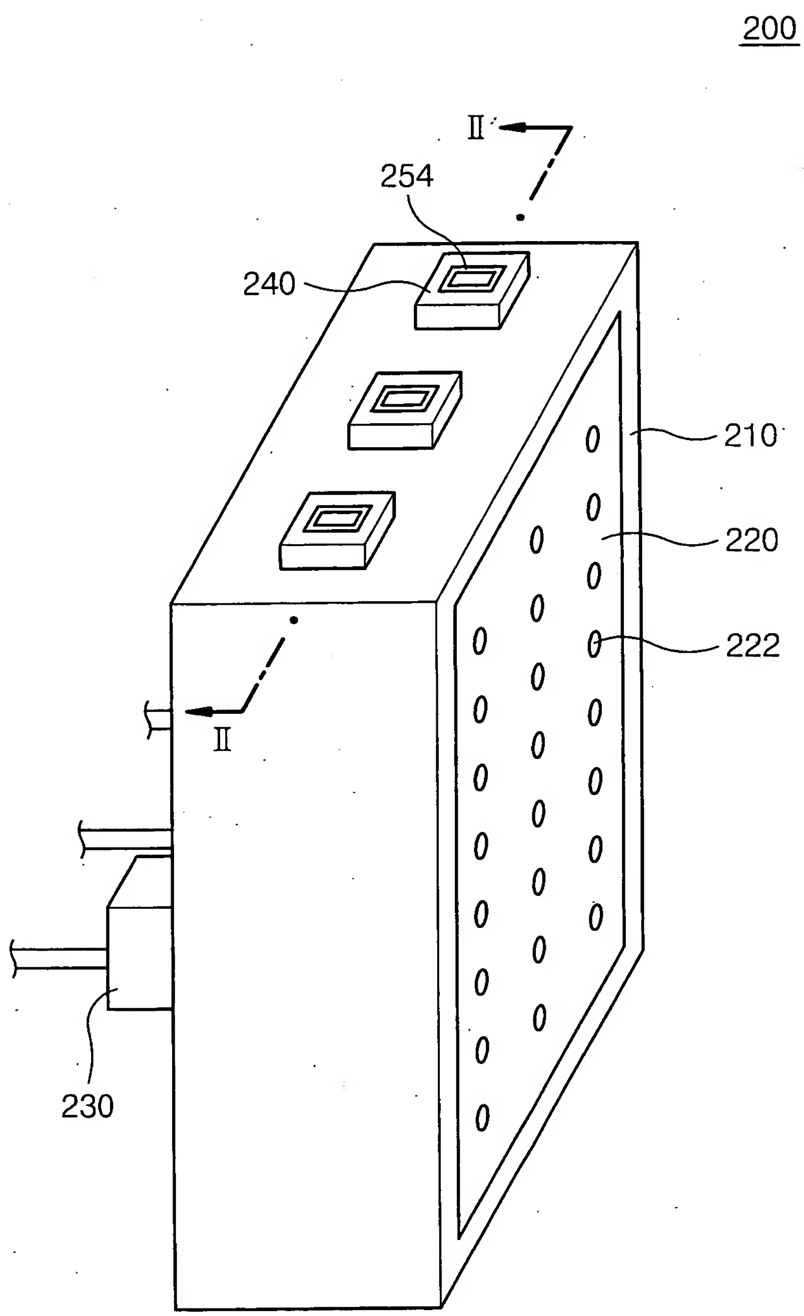

Fig. 7

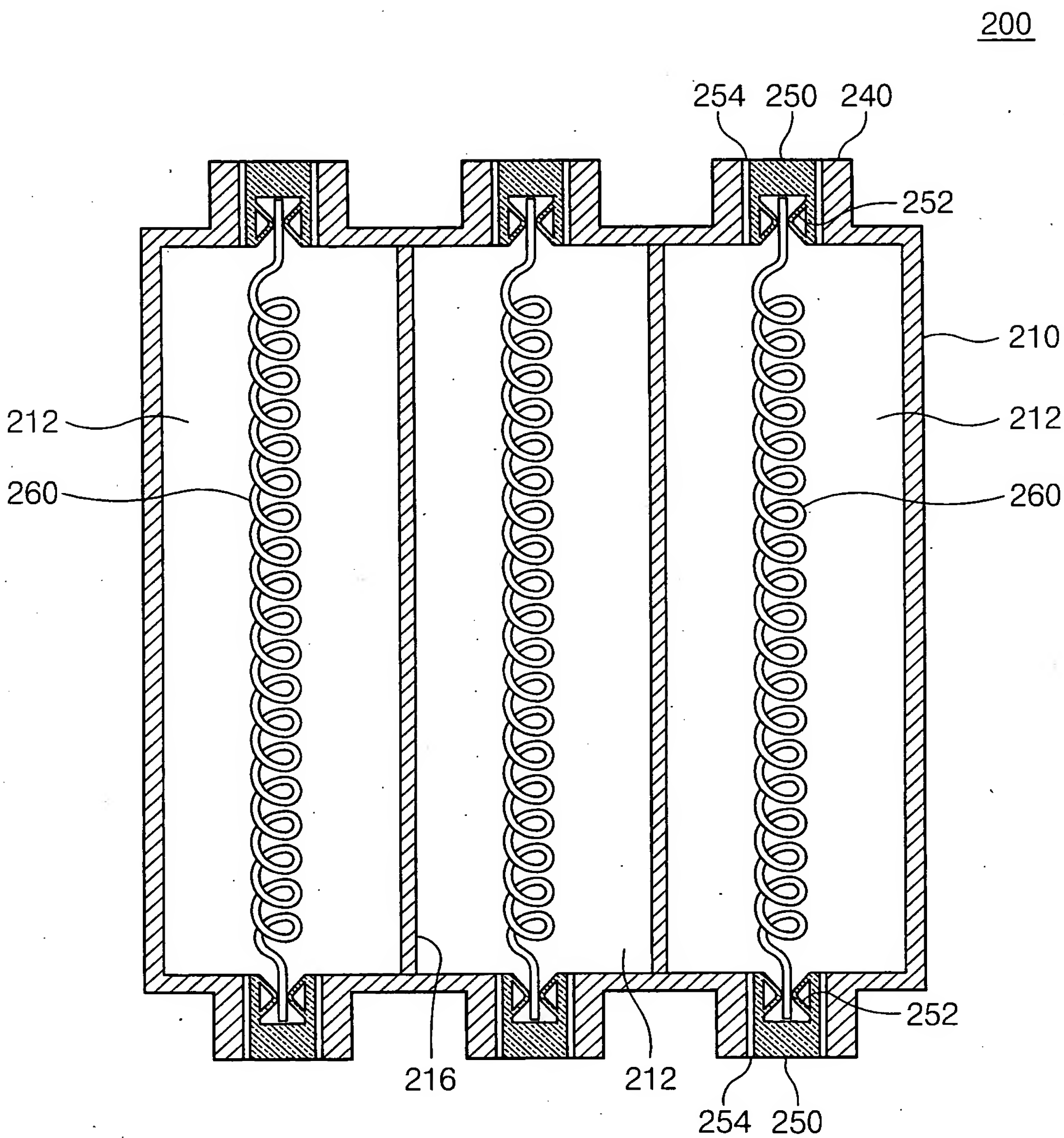

Fig. 8

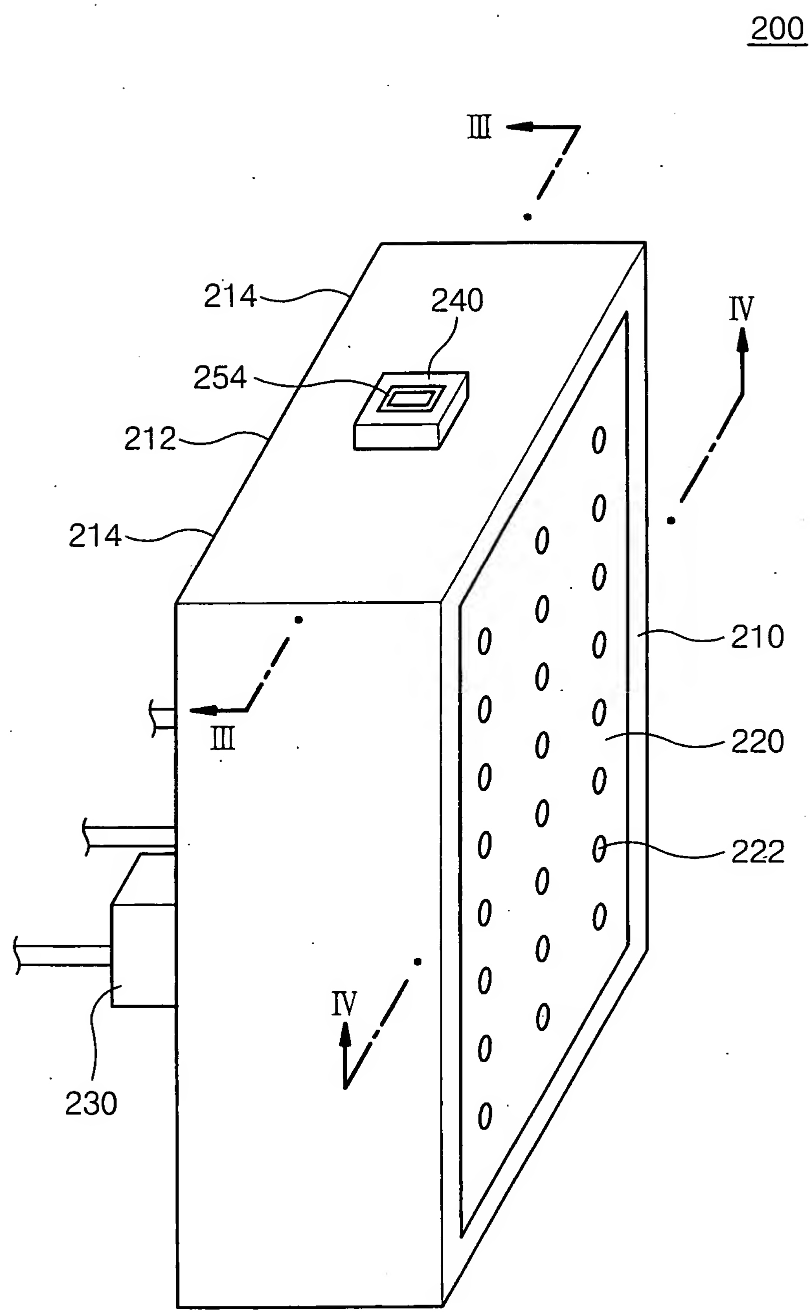

Fig. 9

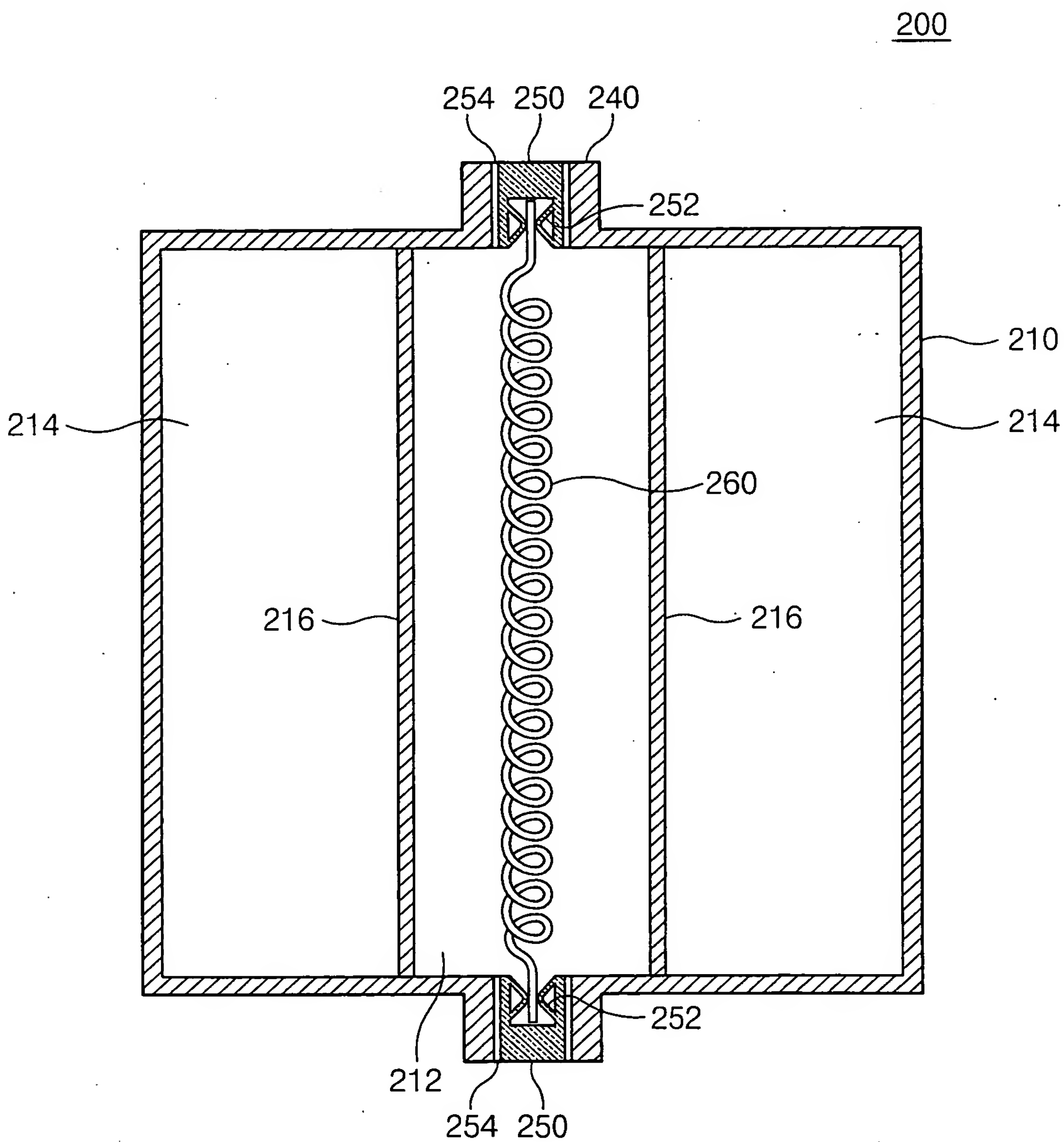

Fig. 10

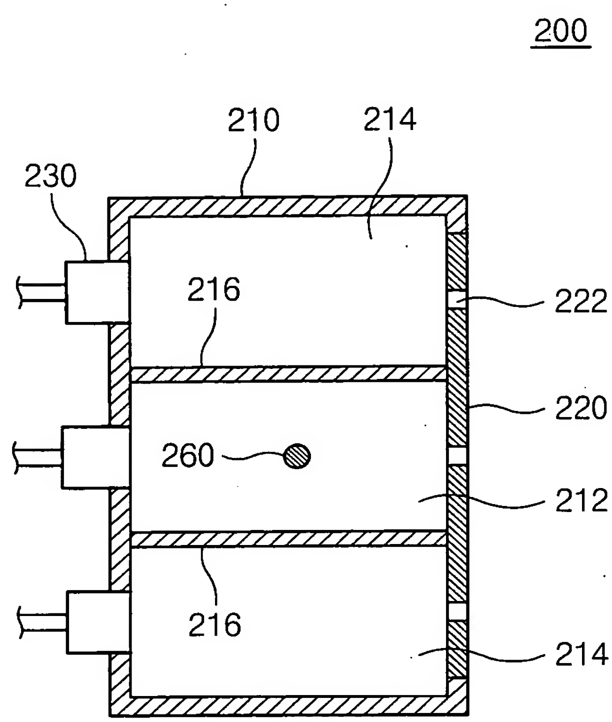

Fig. 11

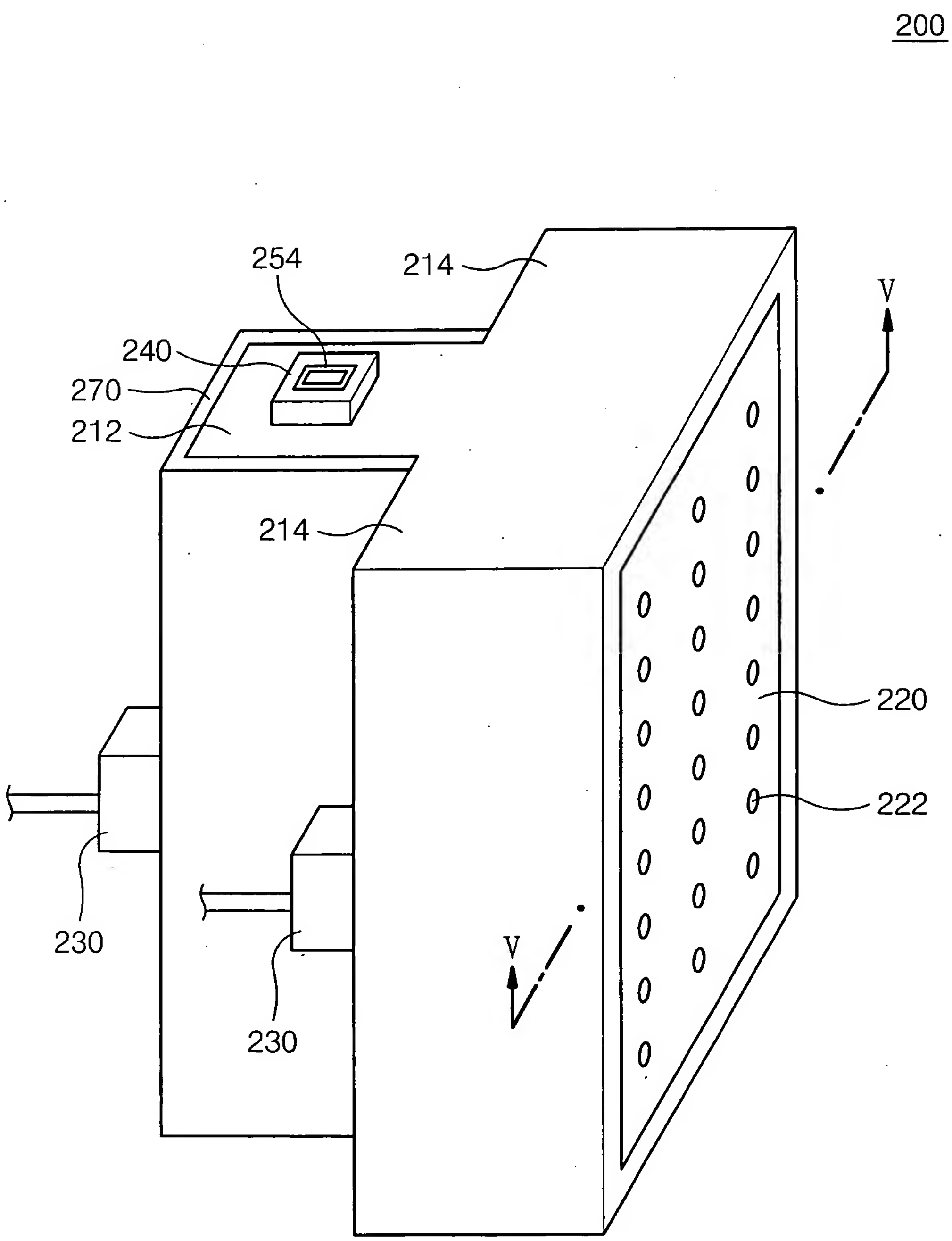

Fig. 12